Low cost chemical sensors for monitoring soil nutrients: progress and opportunities

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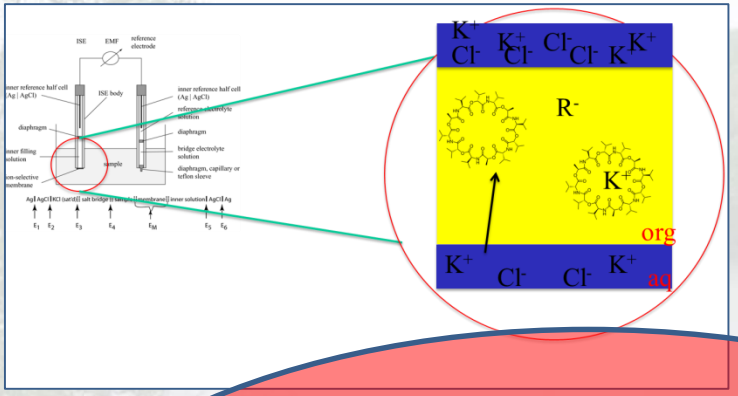
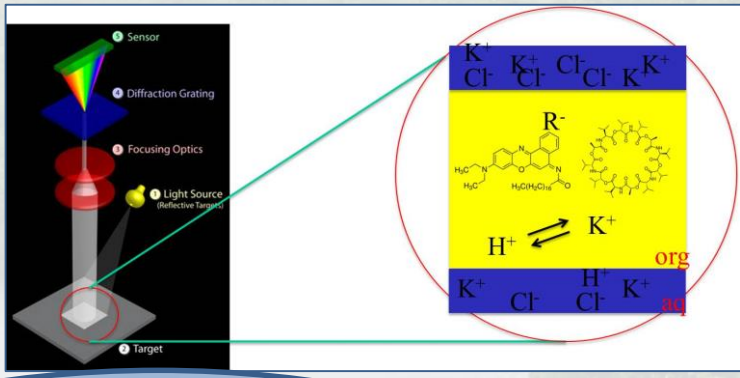
Ionophore-based sensors

Ion-Selective Electrodes (ISEs)



- Need permselective membrane
- Require only one ionophore
- Response dictated by localized surface phenomena
- Universal equation for fitting response

Optodes



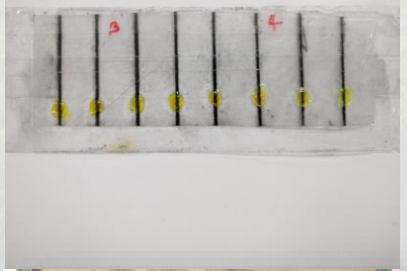
- Working mechanism is based on chemical equilibria
- Signal depends on ACTIVITY of target ion
- Extraordinarily large sensitivity range (up to 12 orders of magnitude)
- Essential parts are polymeric membrane (water-immiscible)
- ion carrier (ionophore) and ion-exchanger

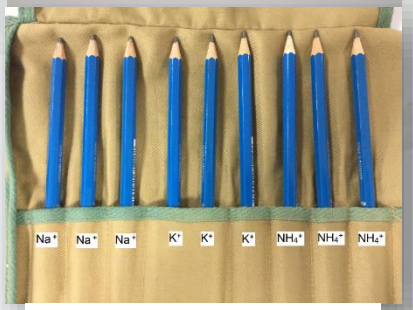
- Multiple ions can/should be extracted
- Require two ionophores
- Response depends on equilibria within the bulk - bulk optodes
- Response is fitted based on all equilibria involved

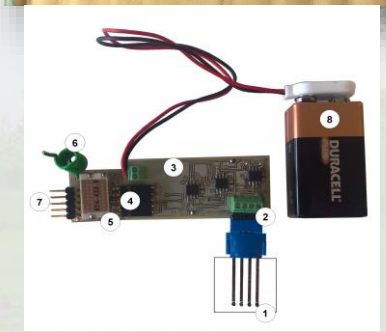
Ion-Selective Electrodes in Environmental analysis – Aleks' take

- Development of
  - Protocols for improvement of LODs (direct determination of CO_3^{2-} in sea water -> LOD~1 ppt)
  - Substrates for easy in situ application,
  - Methodologies for sample processing and analysis
  - Precision and robustness

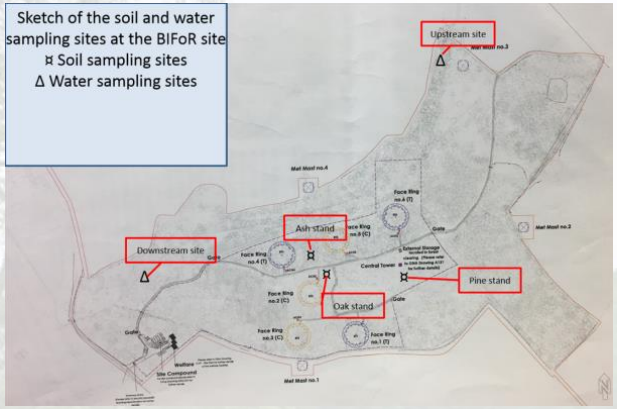
Mendecki L., Stockmal K., Wei J., Granados-Focil S., McGraw C., Radu A.; Robust and ultra-sensitive polymer membrane-based carbonate-selective electrodes; *Analytical Chemistry*, **2015**, 87 (15), 7515-7518; (10.1021/acs.analchem.5b01756)





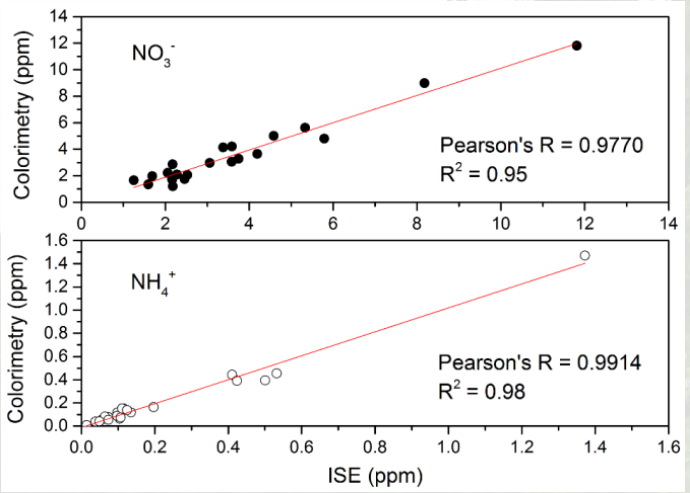


ISEs for Soil Nitrogen (NO_3^- & NH_4^+) at BIFoR

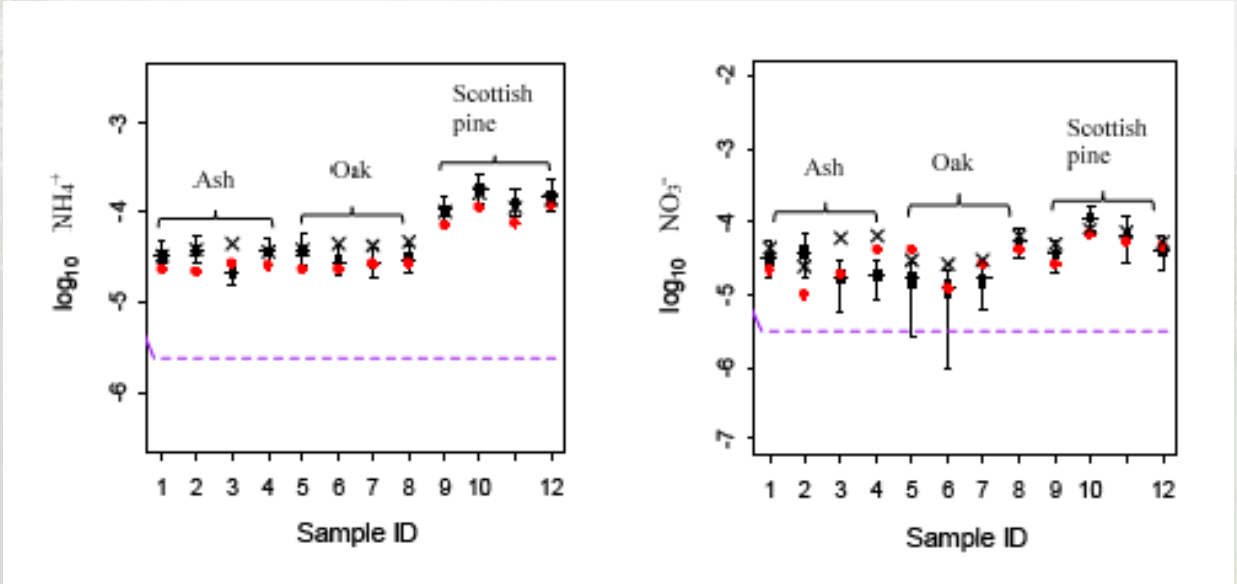


Collected soils at BIFoR under different trees.

Established selectivity, sensitivity and reproducibility of ISE for nitrate and ammonium



Choosang et al 2018; **Simultaneous detection of ammonium and nitrate in environmental samples using on ion-selective electrode and comparison with portable colorimetric assays** *Sensors*; 18(10); 3555

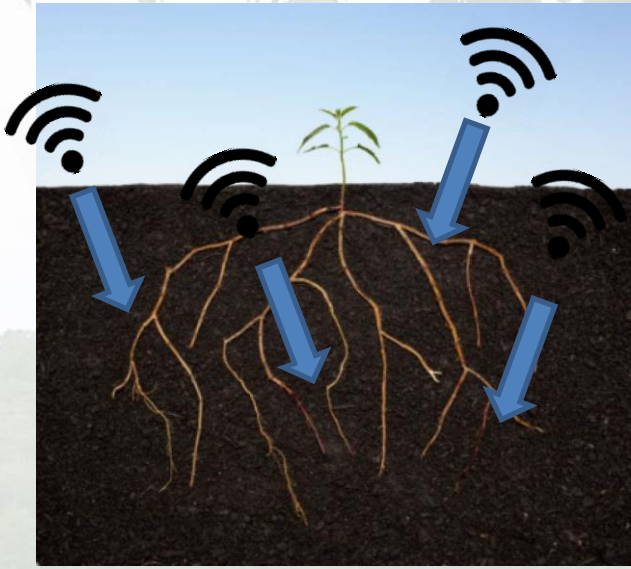


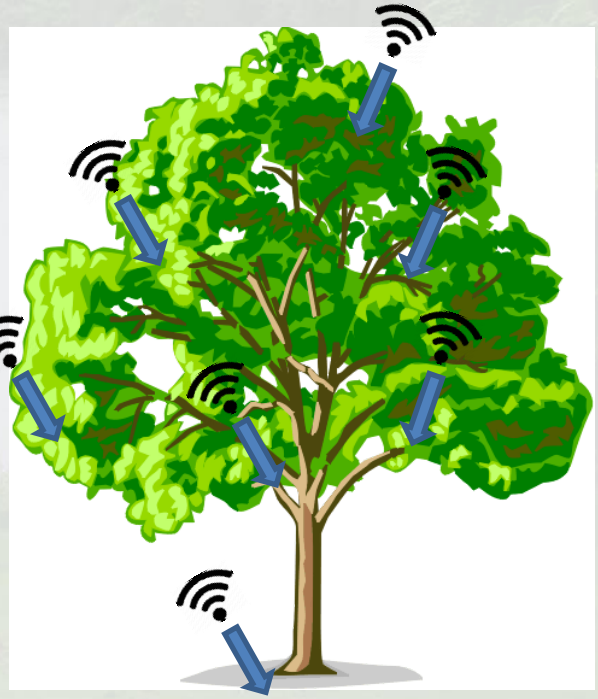
Fayose et al; unpublished data

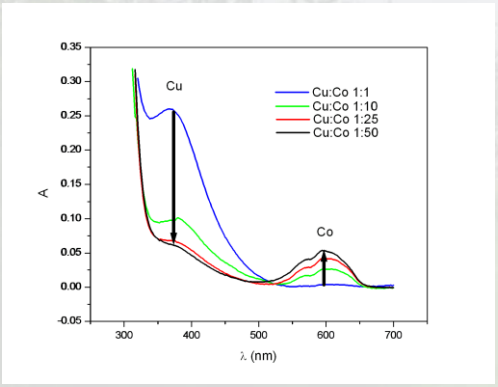
British Council; Institutional Links (Thailand)

Future Research and Opportunities

- Monitoring *in situ* concentration of plant available mineral N
  - (turning disadvantage into advantage; sensors measures only when water is present thus mimicking function of the root)
- Monitoring nutrient uptake by plant organs
- Game changer for *in si*tu high resolution soil nutrient data?
  - Newton Fund (Peru); 2019-2020 New funding to continue our work at BIFoR (Radu and Ullah) on trailing *in situ* sensing







Acknowledgments

- Jittima Choosang
- Suntisak Khumngern
- Martin Jendrlin

- Dr Lukasz Mendecki
- Dr Tolulope Fayose

- Dr Vladimir Zholobenko

- Dr Peter Dillingham

- Dr Sami Ullah at Birmingham University
- Prof Panote Thavarungkul + team from PSU